Research Report 1396

Criterion Performance Measures for M1 Tank Driver Tests

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U. S. Army

Research Institute for the Behavioral and Social Sciences

January 1985

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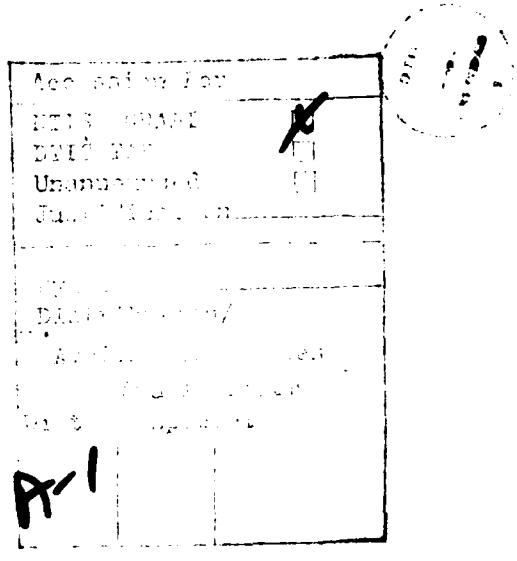

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARI Research Report 1396	2. GOVT ACCESSION NO. AD-A156793 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) CRITERION PERFORMANCE MEASURES FOR M1 TANK DRIVER TESTS	5. TYPE OF REPORT & PERIOD COVERED Research Report 6. PERFORMING ORG. REPORT NUMBER --
7. AUTHOR(s) Susan L. Burroughs	8. CONTRACT OR GRANT NUMBER(s) --
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue, Alexandria, VA 22333-5600	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q263743A794 3221100 5410
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue, Alexandria, VA 22333-5600	12. REPORT DATE January 1985 13. NUMBER OF PAGES 76
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) --	15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE --

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

--

18. SUPPLEMENTARY NOTES

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

M1 training	Non-procedural tasks
M1 driver simulator	Performance testing
Driver testing	Criterion measures
Tank driving	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of this research was to establish criterion measures for previously developed M1 Tank Driver Tests. The scoring techniques for eight driver tests were revised in accordance with suggestions made in the original M1 Tank Test report. The tests were administered to 40 experienced M1 tank drivers. Performance scores of experienced M1 tank drivers were then compared to M1 OSUT trainee drivers' performance scores to determine performance changes which occur with driving practice. The identified performance changes helped set the parameters constituting the acceptable range of (Continued)

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i SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ARI Research Report 1396

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scores for drivers to achieve after the basic driving course. The criterion measures will also be useful in determining standards against which driver simulator performance can be compared.

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Criterion Performance Measures for M1 Tank Driver Tests

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Office, Deputy Chief of Staff for Personnel
Department of the Army

January 1985

Army Project Number
2Q263743A794

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FOREWORD

The Automated Training Technology team of the Army Research Institute for the Behavioral and Social Sciences (ARI) performs research in areas that include the use of simulators and devices in military training. Of special interest is research in the area of evaluating simulators and devices in terms of transfer of training to the actual weapon system. In order to do this however, specific objective tests of MOS skills must have been developed with criterion performance measures set.

This report provides criterion performance measures for reliable tests of non-procedural M1 tank driver skills that could serve as standards for tank driver simulator training. The tests could also be of service to the Army for the determination of how well soldiers perform the different skills that are required of tank drivers.

The driving tests can have further application as criterion measures for evaluating tank driver performance under degraded modes. Tank Driving Tests can also prove valuable in evaluating new tank design concepts such as those being incorporated in the Surrogate Research Vehicle and Tank Test Bed.

EDGAR M. JOHNSON
Technical Director

CRITERION PERFORMANCE MEASURES FOR M1 TANK DRIVER TESTS

EXECUTIVE SUMMARY

Requirement:

Establish criterion measures for on-tank tests of nonprocedural, perceptual, and tactical M1 tank driving skills.

Procedure:

Eight driving tests were administered to 40 experienced M1 tank drivers. Performance scores of the experienced M1 tank drivers were then compared to M1 OSUT novice drivers' performance scores obtained during earlier tests to determine performance changes which occur with driving practice. The performance changes set the parameters constituting the acceptable range of scores for drivers to achieve after the basic driving course.

Findings:

Criterion measures were established for each of the eight tests based on novice and experienced M1 tank drivers performance scores. Based on the data from experienced M1 tank drivers, some measures were modified and some completely dropped. Features that might offset the established standards in future testing are the effect of the test conditions such as terrain, weather, surface conditions and vehicle operations. Time measurements will likely be changed by adverse conditions, but the majority of measures will remain fairly stable under adverse conditions.

Utilization of Findings:

Based on the initial results from novice drivers and test modifications used for the experienced drivers, there is evidence that these tests are reliable quantitative instruments for measuring performance and producing criteria to use in yardstick comparisons with simulator-measured skills. The tests may also be useful in general field applications for training and testing of tank driver performance.

CRITERION PERFORMANCE MEASURES FOR M1 TANK DRIVER TESTS

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CRITERION PERFORMANCE MEASURES FOR M1 TANK DRIVER TESTS

INTRODUCTION

Available safety data collected over the past few years do not indicate sufficient emphasis on tracked vehicle driver training in the US Army. Safety concerns in peacetime have brought driving problems and, therefore, training program deficiencies to the forefront. During peacetime tanks are restricted to civilian roads. This causes concern for safety, particularly with the faster, more responsive and complex M1 tank. The M1's capabilities leave less room for driver error. Driver error has been particularly evident in USAREUR where a majority of training time is spent traveling public roads. In CY 81 tracked vehicle accidents increased 21% over CY 80 (Countermeasure, July 1982).

More than 50% of tracked vehicle accidents in CONUS and USAREUR were caused by driver error. During FY 80, 55 tanks were involved in accidents with another vehicle and 47 struck objects (buildings, utility poles, etc.). Eighty percent of these accidents were in USAREUR (Countermeasure, Nov 1982). Between FY 77 and FY 81, in excess of five million dollars were spent by the US Government because of tracked vehicle accidents (U.S. Army Safety Center, 1982). These accidents resulted in 23 fatalities and 335 disabling injuries and almost 5,000 lost workdays. During this period there were five M1 accidents, resulting in $53,000 property damage, three of the five were attributed to driver error. It should be noted that during this time period relatively few M1's were being driven. These safety records point to the need for improved driver training and education in the US Army.

Currently, initial entry soldiers in armor Military Occupational Specialities (MOSs) receive One Station Unit Training (OSUT) which includes 10 weeks of instruction on MOS related skills. Initial entry soldiers are instructed on basic skills required of gunners, drivers, and loaders with the major emphasis on gunner and loader skills. Driver training is allocated 28 hours in the OSUT program of instruction. Battery II is given during this phase. The Battery II test is a series of written and manual tests which determine if a driver has good overall judgment, vision, and eye-hand coordination. Initial entry soldiers must successfully pass the Battery II before they can drive the tank. Actual operation of the tank is taught in an eight (8) hour block of instruction. Soldiers receive one (1) hour of "actual driving time" divided between day and night driving. Training entails driving the tank on an obstacle free macadam oval. Informal evaluation of the initial entry soldier's performance called training site certification (TSC) is given during the daytime driving on the fourth time around the oval. During night driving, no evaluation is made of soldier performance. Soldiers receive little driver training that is combat oriented. Soldiers passing the defensive driving course, Battery II Tests, and TSC are eligible to receive a license when they satisfactorily complete any additional requirements of combat units to which they are assigned after training.

Selection of tank drivers is usually done at the unit level by the unit commander, platoon leader, platoon sergeant, or tank commander. The tank

Table 13

Time Statistics for Acceleration and Stopping Test

	Time (Seconds)[1]	
Measurement	Novices (N = 30)	Experienced (N = 40)
M	23.6	14.4
SD	6.9	3.5
Range	8 - 48	9 - 25

1. The course was 90 meters longer for the experienced drivers than for the novices and therefore times are not comparable.

A measurement was made from the stop line to where the tank actually stopped. During testing, drivers were not allowed to stop and then move forward to the line; drivers were measured from where movement of the tank first halted. Twelve experienced drivers went over the stopline, while all novice drivers stopped short of the stopline (Table 14). There was no difference in distance between experienced drivers and novices who stopped short of the line, or on absolute stopping distance. The actual variability in experienced drivers' error distance (SD = 14.12) is significantly greater than for novices ($F = 2.34$, $p < .01$). One possible explanation is that the experienced drivers while driving a longer distance drove much faster than the novice drivers, and therefore it took a longer distance to stop.

Table 14

Error Distance Statistics on Acceleration and Stopping Test

	Error Distance (Feet)		
Distance	Novices	Experienced	T
Over	N = 0	N = 12	
M		10.5	
SD		8.47	
Range		+1, +30	
Under	N = 32	N = 28	
M	9.27	12.11	1.139
SD	9.23	9.98	
Range	0, -40	-1, -40	
Absolute	N = 32	N = 40	
M	9.27	11.62	1.061
SD	9.23	9.48	
Range	0, 40	1, 40	

Table 11

Number of Gate Strikes Over All Gates for Width Judgment Test

	Number of Soldiers Who Attempted Both 169" and 157" Gates	
Number of Gates Struck	Novices (N = 31)	Experienced (N = 33)
Two	0 (0%)	1 (3%)
One	9 (29%)	11 (33%)
None	22 (71%)	21 (63%)

Kolmogorov-Smirnov D = .074, $p > .10$

Engagement times were also measured for novices and experienced drivers. The course for the experienced drivers was 50 meters shorter than for the novices. However, the mean time for experienced drivers was longer even though the course was shorter (Table 12). The novice course was easier than the experienced driver course, in that it was smoother and the target was straight ahead. The experienced driver course was over rough terrain and the driver had to orient the tank to a target which required him to turn the tank. Because of the differences between the two courses, no analysis of mean time differences was made.

Table 12

Time Statistics on Control Tank During Main Gun Engagement Test

	Time (Seconds)[1]	
Measurement	Novices (N = 32)	Experienced (N = 40)
M	34.9	54.9
SD	11.8	16.7
Range	17 - 65	29 - 105

1. The course was 50 meters shorter for the experienced drivers than for the novices and therefore times are not comparable.

Acceleration and Stopping. The measurements taken consisted of time from start to stop and distance over or short of the stop line. The distance traveled by the experienced drivers was 150 meters while the novice drivers drove only 60 meters. Even though the experienced drivers had a greater distance to drive, they had shorter times (Table 13).

experienced drivers struck as many of the passable gates as did the novices (Table 11). One possible explanation for the similar strike results between experienced drivers and novices, based on scorer observations, is that the novices hit the barriers even though they drove slowly, because they were not skilled at precision driving, while experienced drivers drove more quickly, sacrificing precision for speed.

Table 9

Number of Correct Decisions Over All Gates for Width Judgment Test

	Number of Soldiers	
Number of Correct Decisions	Novices (N = 43)	Experienced (N = 40)
Three	22 (51.2%)	28 (70%)
Two	15 (35.9%)	10 (25%)
One	6 (14%)	1 (2.5%)
None	0 (0%)	1 (2.5%)

Kolmogorov-Smirnov D = .188, $p > .10$

Table 10

Number of Soldiers With Gate Strikes By Gate for Width Judgment Test

	Novices		Experienced		
Gate Width	Number of Attempts	Number of Soldiers with strikes	Number of Attempts	Number of Soldiers with strikes	Z
169 inches	35	7 (20%)	38	6 (16%)	.470
157 inches	35	4 (11.4%)	33	8 (24%)	1.385
Total	70	11	71	14	.624

Control Tank During Main Gun Engagement. Because of a scorer misunderstanding, data were gathered from only eight novices on the transmission shift measure. Therefore, when testing the experienced drivers, there was also a need to establish scorer reliability. The tank commander and a ground observer counted the number of transmission shifts during the exercise. It turned out that the scorer counts were not the same ($r = .088$, $p > .05$). From these data, it is concluded that the transmission shift measure should be dropped because of the difficulty in obtaining reliable data.

Table 7

Number of Barrier Strikes on Align Tank for Width Test and Test of Differences of Proportions

	Number of Soldiers		
Sides	Novices	Experienced	Z
Right	N = 40	N = 40	
One Strike	8 (20%)	4 (10%)	1.268
No Strikes	32 (80%)	36 (90%)	
Left	N = 43	N = 40	
One Strike	7 (16.3%)	1 (2.5%)	2.126*
No Strikes	36 (83.7%)	39 (97.5%)	
Combined	N = 40	N = 40	
One Strike	13 (32.5%)	5 (12.5%)	2.142*
No Strikes	27 (67.5%)	35 (87.5%)	

* $p < .05$

Table 8

Number of Correct Decisions by Gate for Width Judgment Test and Test of Differences of Proportions

		Number of Soldier's		
Gate Width	Correct Decision	Novices (N = 43)	Experienced (N = 40)	Z
169 inches	Attempt	35 (81.4%)	38 (95%)	1.903*
157 inches	Attempt	36 (83.7%)	33 (82.5%)	.148
144 inches	Bypass	31 (72.1%)	34 (85%)	1.425

* $p < .10$

Each soldier was also scored on whether or not he cleared the gate when he attempted it (Table 10). Out of the 71 possible opportunities for strikes, when experienced drivers attempted the passable gates, strikes occurred in only 19.7 percent of the cases (14 strikes). Novices were similar in performance with 15.7 percent (11 strikes) out of 70 opportunities for strikes occurring. None of the differences of proportion tests between novice and experienced drivers for number of strikes were significant, indicating that for drivers who attempted the gates, novices and experienced drivers were equally as likely to strike the gate. The results from number of soldiers who attempted both the 169-inch and 157-inch gates showed that the

number of correct decisions over all gates between novices and experienced drivers (Table 9).

Table 5

Time Statistics on Right and Left Turns Test

	Time (Seconds)[1]	
Turn	Novices	Experienced
Right	N = 44	N = 40
M	61.7	30.5
SD	24.0	16.5
Range	29 - 133	14 - 85
Left	N = 42	N = 40
M	57.1	31.7
SD	22.3	15.3
Range	24 - 106	14 - 85
Total (Av)	N = 42	N = 40
M	59.6	31.1
SD	23.4	15.86
Range	24 - 133	14 - 85

1. The course was 15 meters shorter for the experienced drivers than for the novices and therefore times are not comparable.

Table 6

Turn Radius Statistics on Right and Left Turns Test

	Turn Radius		
Turn	Novices	Experienced	F
Right	N = 44	N = 40	
M	17'9"	16'2"	
SD	5'6"	1'1"	28.99*
Range	10'6" - 33'6"	12'2" - 18'7"	
Left	N = 44	N = 40	
M	19'6"	16'3"	
SD	5'10"	1'3"	19.67*
Range	12'2" - 31'6"	12'4" - 19'5"	
Total (Av)	N = 44	N = 40	
M	18'7"	16'2"	
SD	5'2"	1'0"	12.43*
Range	10'6" - 33'6"	12'2" - 19'5"	

*$p < .01$

Table 4

Number of Barrier Strikes on Right and Left Turns Test

	Number of Soldiers					
	Novices			Experienced		
Turns	Before Turn	During Turn	After Turn	Before Turn	During Turn	After Turn
Right		N = 40			N = 40	
Two or more Strikes	2	0	0	0	1	0
One Strike	3	9	4	3	2	1
No Strikes	35	31	36	37	37	39
Left		N = 39			N = 40	
Two or More Strikes	0	1	0	0	3	0
One Strike	3	6	0	0	0	0
No Strikes	36	32	39	40	37	40
Overall segments of both turns						
Two or More Strikes			6			4
One Strike			14			4
No Strikes			18			32

Kolmogorov-Smirnov D = .326, $p < .05$

Align Tank for Width. Drivers were required to pass between two barriers that narrowed to just over tank width at the exit end. The drivers were required to make a turn into the barrier passage to avoid having the tank already lined up or almost lined up with the passage; they also made a turn coming out of the passage. Based on observations, very few drivers had problems lining up the tank after the turn for entry into the passage. Hits among novices occurred on both left and right barrier sides, while the experienced drivers were more likely to strike the right barrier (Table 7). Table 7 shows that there was a significant difference between novices and experienced drivers on left side strikes. When the sides were combined, more novices hit a barrier than experienced drivers.

Width Judgment. An incorrect decision was scored if a driver tried to drive through the 144-inch gate or if he bypassed the 157-inch or 169-inch gates. As shown in Table 8, there were as many experienced drivers with incorrect decisions on the 157-inch gate as on the 144-inch gate. The experienced drivers had no problem with the 169-inch gate, while the judgment about the 144-inch gate was significantly worse. Novices and experienced drivers were similar in the number of attempts they made overall, on all gates (66.34% vs. 64.17%). The experienced drivers, however, were significantly better (made more correct decisions) than the novices on the 169-inch gate (Table 8). There was no difference (Kolmogorov-Smirnov) in the total

Table 3

Time Statistics on Follow Ground Guide Signals Test

Turns		Time (Seconds)[1] Novices	Experienced
Right		N = 19	N = 16
	M	102.0	45.2
	SD	30.8	12.2
	Range	55-153	35-83
Left		N = 19	N = 24
	M	109.9	53.4
	SD	37.3	17.1
	Range	56-193	30-85
Combined		N = 38	N = 40
	M	105.9	50.1
	SD	33.5	15.7
	Range	55-193	30-85

1. The length of the course was 15 meters shorter for the experienced drivers than for the novices and therefore times are not comparable.

None of the tests of differences between culmulative frequency distributions (Kolmogorov-Smirnov) for strikes on right and left turns, on strikes before, during, or after the turn, or across the turn segments showed a significant difference between novices and experienced drivers. The lower portion of Table 4 shows the number of drivers with two or more strikes, one strike or no strikes on the combined turns over all segments. The Kolmogorov-Smirnov test shows that experienced drivers tend to have fewer strikes.

For the novice group, neither the mean difference in time (Table 5) nor the mean difference in turn radius (Table 6) between the right and left turns is significant. The same is true for the experienced group.

The turn course for the experienced drivers was 15 meters shorter than for the novices, and the average times for the experienced drivers was shorter (Table 5). Because time and distance are confounded, it is of no value to compare novices and experienced drivers on mean time differences.

The large difference in variance between experienced and novice drivers on turn radius (Table 6) indicates that experienced drivers were much less variable in performance than novices. The wide differences also preclude use of analysis of variance to test the differences in mean radius. However, a test of the difference of summed ranks (Mann-Whitney), using the average turn distance of right and left turns for each driver, showed no difference between the two groups (z = .708).

Table 1

Number of Barrier Strikes on Follow Ground Guide Signals Test

	Number of Soldiers	
Turns	Novices	Experienced
Right	N = 19	N = 16
Strikes	4 (21.1%)	4 (25.0%)
No Strikes	15 (78.9%)	12 (75.0%)
Left	N = 19	N = 24
Strikes	6 (31.6%)	3 (12.5%)
No Strikes	13 (68.4%)	21 (87.5%)
Total	N = 38	N = 40
Strikes	10 (26.3%)	7 (17.5%)
No Strikes	28 (73.7%)	33 (82.5%)

Table 2

Partition of Chi-Square on Follow Ground Guide Signals Test

Source	Chi-Square	df	Significance
Total	3.172	1	-
Group x Direction	.788	1	-
Group x Strike	.888	1	-
Direction x Strike	.042	1	-
Group x Direction x Strike	1.454	1	-

The length of the course was 15 meters shorter for the experienced drivers than the novices and the average time for the experienced drivers was shorter (Table 3). Because time and distance are confounded, it is of no value to compare novices and experienced drivers on time differences.

Right and Left Turns. The total number of barrier strikes was recorded in each category (Before, During, and After Turn) for the two turns (driving forward) for each soldier. A record was kept if the driver struck the barrier no times, one time or two or more times, and the locations where the strikes occurred. For experienced drivers ($z = -2.138$, $p < .05$) and novices ($z = -1.662$, $p < .10$), the right turn was more difficult-approximately twice as many soldiers had strikes during the right turn than during the left (Table 4). Although the reason for the difference in performance is not immediately obvious, one contributing factor could be that the M1 driver's hatch is on the driver's right when open and partially obscures vision on the right side.

drivers course for the React to TC Command (Hull Defilade) test was 50 meters longer than the novices. The experienced drivers scorer was on a rise in the ground, whereas the novices course scorer was not. Also the defilade position for the experienced drivers was smaller than the novices position, and therefore, led to a more difficult test. These test course differences and how they reflect on the data are discussed in the results section.

RESULTS

Two major sets of analyses were performed on the M1 driving test data. The first concerns analysis of the experienced drivers' performance scores. The second concerns measurement of performance changes which occur with driving practice and is obtained by comparing the experienced drivers' scores with the previously obtained novice drivers' performance scores (Campbell et al., 1983). Identification of performance changes will determine the acceptable range of scores for drivers to achieve after the basic driving course. Further, the development of criterion measures for conventional training can be of use in determining the effectiveness of simulator-based driver training. The two analyses are presented for each of the eight tests. Since the performance differences between novice and experienced drivers was not known, the research was considered exploratory. The statistics were used to determine if differences existed and if so, to what extent. Therefore, the level of confidence was not set before hand.

Results for the Tests

Follow Ground Guide Signals. The tank driver, while driving in reverse, followed the signals from the ground guide to his front. Observation and debriefing did not identify any instances of ground guide induced barrier strikes or delays.

The data collected during the Ground Guide test included the time and whether there was a barrier strike or not. One observer scored whether or not a strike occurred. The number of soldiers who struck the barrier was low for both right turns and left turns. The data indicated that 4 (25%) of the 16 soldiers making right turns and 3 (12.5%) of the 24 soldiers making left turns struck the barrier. The data (see Table 1) for novices indicate that left turns are slightly more difficult than right turns. The results from the experienced drivers suggest that any difference in difficulty between right and left is erased after practice. A three-way chi square showed no significant difference in strikes between novices and experienced drivers on right and left turns (Table 2). There was also no significant difference in proportion (z = .943) of novices and experienced drivers who had barrier strikes. The time required to perform the test did not differ for right and left turns for experienced drivers (t = 1.769, p > .20), and was varied enough across experienced drivers and across novices to be useful in discriminating proficiency levels within each group (Table 3). Because of the time problems in large scale administration of both right and left turn versions of the test, and the indications from both groups that the two turns are of comparable difficulty, testing of either turn is sufficient.

the course with ARI personnel acting as TC. The 2/6 Cav TC then moved up to the TC position and directed another 2/6 Cav TC in the driver's hatch around the course. This process continued until all six TCs drove around the course and also acted as TC for a driver being tested on the course. In this way, it was possible to obtain scores for each TC, to train the TC for guiding and scoring drivers through the course and to train the NCO scorers. On the second day, five M1 tanks were run simultaneously around the course with the 5 TCs (one alternate) that were trained the previous day.

Test Organization. An oval course approximately 1-1/2 miles long was set up with the eight tests. Each soldier remained in the same tank for all his tests. The obstacle/judgment tests were run first with driver's compartment hatch open in the following sequence:

- Right and left turns
- Follow ground guides
- Width judgment
- Align tank for width

The right and left turns and follow ground guides test were run on the same stretch of terrain. After the first driver finished both tests and was on the way to width judgment, the second tank started the course at right and left turns. This sequence continued until all five tanks were running on the course. The tactical tests followed the obstacle/judgment tests and were given closed hatch in the following sequence:

- TC command, missile duck
- Acceleration/stop
- TC command, hull defilade
- Main gun engagement

Differences Between Novice and Experienced Drivers Course Structure

The experienced drivers driving course had to be set up in an area approximately 1000 meters from the novices course because of unavailability of the original test area. As a result, several of the tests had to be structured to the terrain which changed the driving distance from that of the original novice test. For these tests, time and variance comparisons with the novice data could not be made.

The Follow Ground Guide Signals and Right and Left Turns tests were both done at the same test site. This test site was 15 meters shorter than the novices test site. The Control Tank Driving Main Gun Engagement test was 50 meters shorter for the experienced drivers than for the novices. The experienced driver course was also over rougher terrain than the novices. In the Acceleration and Stopping test the experienced drivers course was 90 meters longer than the novices course. On the React to TC Command (Missile, Duck) test the experienced drivers course was 200 meters longer than the novices course. Further the scorer was placed 100 meters from the novices test and at 50 meters for the experienced drivers test. The scorer for the experienced drivers was on a rise in the ground. The route to the final position for the experienced driver had no concealment opportunities while the route for the novices had many opportunities for concealment. The experienced

Acceleration and Stopping. The driver, on command and from a stop, accelerated as fast as possible and stopped as close as he could to a marked line within right and left boundaries. Measures included the driver's skills in judging tank stopping distance and his ability to control the tank in rapid acceleration/rapid deceleration conditions.

React to TC Command-Missile, Duck. Upon command, the driver was expected to move to a position of total defilade. Skills measured were the driver's reaction time, vehicle control, vehicle position control, vehicle position and the ability to obtain hull defilade. To some extent the test was to measure the driver's understanding of the hull defilade concept. Subjective TC evaluations were gathered for experimental use.

React to TC Command-Hull Defilade. Upon command, the driver was to move to a position of hull defilade with the gun capable of engaging the target (free of obstructions). Skills measured were the driver's reaction time, vehicle control, vehicle position control, vehicle position and the ability to obtain hull defilade. To some extent the test was to measure the driver's understanding of the hull defilade concept. Subjective TC evaluations were gathered for experimental use.

Testing

Testing Schedule. Testing of experienced drivers was conducted over a two day period. On the first day, six tank commanders (TCs) were tested. On the second day, 34 soldiers were tested. Testing was done at Fort Knox, Kentucky at Training Area 13 which afforded room and terrain variation.

Subjects. Twenty-one 2/6 Cav, H Company experienced soldiers were tested. Included in this group were six tank commanders who later served as test scorers. Nineteen experienced 1st AIT/OSUT Bde, Companies A and B hold-over soldiers were also tested. All soldiers were M1 qualified drivers. Their experiences in driving ranged from one month to 26 months on the M1 tank and from one month to 132 months on the M60 series tank. Most of the 2/6 Cav soldiers had unit driving experience at Fort Hood or overseas. This included some unit tactical driver training. The 1st AIT/OSUT Bde holdover soldiers had been through the initial entry soldier driving program and then remained at Ft Knox. Their driving experience was mainly driving to and from ranges on black top and limited cross country driving. They had not driven in tactical scenarios.

M1 qualified drivers' performance was to be compared to novice drivers' scores from the same tests administered the year before. The initial entry soldiers used on the earlier test session consisted of 44 M1 OSUT soldiers tested on the Obstacle/Judgment tests and 33 different M1 OSUT soldiers tested on the tactical tests. Both groups previous hands-on driver training consisted of approximately 15 minutes of driving on the macadam flat oval training site certification course. In this report, these initial entry soldiers are referred to as novice drivers and their performance scores are included in the tables for comparison to the experienced drivers scores.

Scorers. On the first day of testing, 15 NCO CMF 19 soldiers from 2/6 Cav and 1st AIT/OSUT Bde were trained to score the tests. A 2/6 Cav TC drove

METHOD

Synopses of M1 Tank Driver Obstacle/Judgment Tests

A brief synopis of each driving test is contained below. The tests and scoresheets are presented in Appendix A.

Follow Ground Guide Signals. This test was designed to measure the driver's skill in responding to ground guide signals in a tight maneuver situation. Because a ground guide is used, the control of the tank is essentially the ground guide's responsibility. Any barrier strikes were assumed to be the result of the failure of the driver to respond correctly to the ground guide signals. Time measures reflected the need for adjustments in movement. All tank movement was in reverse, with steering opposite that of forward movement.

Right and Left Turns. Designed to measure the driver's skill in maneuvering in a constricted area without assistance. The driver's instructions were to stay as close as possible to an engineer tape barrier without striking it. Two 90 degree turns, one left and one right, were included. The barrier existed on only one side of the tank; the other side was open.

Align Tank for Width. Designed to measure the driver's ability to control and adjust the position of the tank within narrow confines without assistance. Drivers negotiated a straight passage with engineer tape barriers on each side. The passage entrance was 205 inches and each side narrowed to a 157 inch exit. The barrier was set at fender height. The drivers made a 90 degree or greater turn into the passage about 10 meters from the passage entrance.

Width Judgment. This test consisted of three sets of moveable gates, one set of which was too narrow for the tank to pass through (144 inches). The other gates were set at 157 inches and 169 inches. If the driver judged that he could clear the set of gates, he was to drive through the gate; if he judged he did not have clearance, he was to bypass. The location of the narrow gate was changed after each examinee. Skills measured included accuracy of each width judgment, steering and positioning of the tank, control of the tank, and a time measure reflecting both the decision and control.

Synopses of M1 Tank Driver Tactical Tests

Control Tank During Main Gun Engagement. Designed to measure the driver's skill at minimizing movement that interferes with the gunner while engaging targets on the move. It was also to identify driver behavior in orienting the front of the tank toward the target and in reacting to impassible obstacles in the path of the tank during the engagement. Primary measures were to be the gunner's evaluation of the percentage of time he was able to maintain lay on the target and a count of the number of transmission shifts during the engagement. Time to traverse the standardized engagement distance reflected the driver's ability to maintain a constant speed. Subjective TC evaluations were gathered for experimental use.

In FY 81, ARI began a research program to identify critical subtasks inherent in tactical driving that should be taught in the basic driving program. The research effort first collected responses from questionnaires given to M1 driving instructors, Subject Matter Experts (SMEs) with M1 driving experience and New Equipment Training Team (NETT) members who had extensive experience with the M1 tank. Identified critical tasks were: driving on varying terrain (hills, rivers, steep slopes, etc.), in a convoy, across obstacles, and in tactical combat situations. Throttle, brake, and steering control in relation to driver decision making tasks based on perceptual judgments which vary in difficulty were also listed as critical skills to be learned (Burroughs, 1981).

The information gathered from the questionnaires and interviews with the soldiers and personnel from the Fort Knox Directorate of Training Developments guided the literature search for non-procedural driving skills which are critical to accomplishing combat missions. The perceptual-motor parameters of driving were analyzed to determine where problems might occur within the repertoire of driving skills (Burroughs, 1982). Specific tank driving tasks were then identified which incorporated one or more of the problem areas. A listing of subtasks under five categories was created. These categories were: perform basic driving maneuvers, perform combat driving maneuvers, cross/pass obstacles, avoid exceeding tank operating limits, and perform emergency driving procedures.

The subtasks were assembled into a questionnaire which asked M1 drivers to rate them in three dimensions of criticality: driving practice time needed to become skillful, importance to accomplishing assigned combat missions, and consequences of inadequate performance. Analysis of the data resulted in 13 subtasks which were rated critical in all three categories. Nine of the 13 subtasks were chosen for test development, followed by feasibility and reliability testing (Campbell, Campbell, Knerr, & Burroughs, 1983). Measures of scorer agreement were obtained for all nine tests. The minimum acceptable standard of scorer agreement was set at 80 percent. Also, agreement among several methods of scoring the same skill was measured for some test. The utility of measures, based on their reliability and variability determined which tests and measures were retained for future use. There was ample evidence that eight of the tests hold promise as reliable quantitative instruments for measuring performance and producing criteria to use in yardstick comparisons with simulator measured skills.

Objective

The goal of this research is to develop criterion measures for the M1 tank driver tests. Performance scores of experienced M1 tank drivers will be compared to novice drivers' performance scores to determine performance changes which occur with driving practice. These performance changes will set the parameters which constitute the acceptable range of scores for drivers to achieve after the basic driving course. The purpose of the effort is to develop criterion measures against which driver simulator performance can be compared.

commander is responsible for accomplishing any additional training to ensure the prospective driver is qualified to receive a license. For example in USAREUR, to become a licensed driver, the individual must have passed the Battery II test, received a Defensive Driving Course (DDC) card, and passed a written test composed of recognizing and correctly identifying international road signs. Administration of a road test is a unit responsibility. Road test performance is usually evaluated subjectively by a designated examiner.

The governing regulation, AR 600-55, simply states that: licensee must be able to perform pre-operational checks, know drivers' responsibilities and control the tank under varying conditions. In other words, there is no single standard for evaluating tank drivers for licensing and no requirement for combat driving skills.

To fight and win on the battlefield of the future, tank drivers must be trained to play a vital role. To use their firepower effectively, particularly in the moving mode, tanks must be maneuvered rapidly but smoothly to provide a stable firing platform. The threat of enemy fire requires drivers to select routes, seek cover and concealment, and avoid Antitank Guided Missiles (ATGM), often without guidance. The success of the tactical mission is often dependent upon well-trained drivers. Training drivers in tactical scenarios is a progressive endeavor. Driver proficiency evolves from training under varying operational and terrain conditions. Procedural training in on-road and cross-country driving and obstacle negotiation requires basic subtasks that are necessary to learn before beginning tactical training. While these basic driving skills are not presently taught during OSUT, plans are being made to upgrade the driving program to include basic driving skills, advanced driving which will incorporate various obstacles that expose the driver to field environment driving situations, and tactical driving which integrates driving skills with other required crew duties in a tactical scenario.

Increasing constraints on fuel and other training resources have created the need for the US Army to take full advantage of state-of-the-art technology in devices and simulation in preparing soldiers to become M1 tank drivers. In order to do this effectively, the user must specify exactly what the simulator is to train, how it is to be trained, and how performance is to be measured. These specifications determine the acceptability of the delivered simulator. The first problem is to determine the critical tasks that must be trained. The second problem is to develop valid and reliable on-tank tests of those identified tasks and then to obtain criterion measures for those test. The on-tank tests can then be used to measure the transfer of training from the simulator to the tank and, in so doing, measure the training effectiveness of the simulator.

The Army has decided to purchase an off-the-shelf terrain board tank driver trainer with motion platform. The decision was based on current training needs and the results of other countries' experiences with the terrain board type driver trainer in their respective tank driving programs. Current US Army program plans include the development of an optimum training program using the terrain board type driver trainer. Seven hours on the driver trainer and two hours "actual driving time" have been suggested for the training of basic, advanced, and tactical driving skills.

TC/Scorers also made subjective ratings of stopping (Table 15). Because this subjective evaluation does not relate directly to speed, no correlation was computed with actual times to perform this test. The goal of this test was to both cover the ground quickly and stop smoothly. The test was designed to use skills that are inherent in the pop-up firing technique. When stopping, the driver should not disrupt the gunner by a jerky or abrupt stop. Among both the experienced drivers and novices, about 40% were judged as making smooth stops and 40% as making jerky stops, with considerably fewer drivers scoring in the abrupt category. The distribution across the three rating categories is the same for the two groups. Further, a chi square showed no significant difference across groups or between categories (chi square = .032). It is important to note that both groups scored about 60% in the incorrect response categories.

Table 15

Stop Ratings on Acceleration and Stopping Test

	Number of Soldiers	
Rating	Novices (N = 29)	Experienced (N = 35)
Stopping		
Smooth	11 (38%)	14 (40%)
Jerky	13 (45%)	15 (43%)
Abrupt	5 (17%)	6 (17%)

Kolmogorov-Smirnov D = .021, $p > .10$

React to TC Command - Missile, Duck. All drivers were expected to have problems with the concept and execution of this maneuver; therefore, they were briefed before the run on exactly what the maneuver required. The TC gave subjective ratings on the speed of the move and response to the command once the driver reacted. There was no difference between experienced drivers and novices on the speed rating (Table 16). The majority of experienced drivers had an immediate response to the command while the majority of novices had a delayed response (Table 17). This difference in response rating between the two groups was significant (Table 18). Of the 25 experienced drivers who reacted immediately, all but one were then judged to move fast enough; of the 11 novices who reacted immediately all but one were then judged to move fast enough. Nine experienced drivers had a delayed response, and only two then moved at a fast enough speed; 18 novices had a delayed reaction, and half then moved at a fast enough speed. The difference between the groups on the response and speed interaction was not significant. However, the response by speed interaction over groups was significant with 94% (34 of 36) of the immediate responses scored as fast enough and 41% (11 of 27) of the delayed responses scored fast enough.

Table 16

Speed Ratings on Missile, Duck Test

	Number of Soldiers		
Speed Rating	Novices (N = 29)	Experienced (N = 34)	Z
Fast Enough	19 (65.5%)	26 (76.5%)	-.959
Too Slow	10 (34.5%)	8 (23.5%)	

Table 17

Speed and Time Ratings on Missile, Duck Test

	Response Rating					
	Novices			Experienced		
Speed Rating	Immediate	Delayed	Total	Immediate	Delayed	Total
Fast Enough	10	9	19	24	2	26
Too Slow	1	9	10	1	7	8
Total	11	18	29	25	9	34

Table 18

Partition of Chi-Square on Missile, Duck Test

Source	df	Chi-Square
Total	4	31.434
Group x Response Rating	1	8.099*
Group x Speed Rating	1	.920
Response Rating x Speed Rating	1	21.804*
Group x Response Rating x Speed Rating	1	.612

* $p < .005$

The immediate reaction of experienced drivers and lack of immediate reaction of the novices is also apparent in the times recorded. The experienced drivers required an average of 23.1 seconds to get into position while

the novices required 33.6 seconds (Table 19). It should be pointed out that the experienced drivers' course was 400 meters while the novices' course was 200 meters. Further, 35% of the experienced drivers chose an improper defilade position while 55% of the novices chose an improper position. This difference is statistically significant (Table 20).

Table 19

Time Statistics on Missile, Duck Test

	Time (Seconds)[1]	
Measurement	Novices (N = 31)	Experienced (N = 40)
M	33.6	23.1
SD	17.0	9.3
Range	12 - 61	13 - 46

1. The course was 200 meters longer for experienced drivers than for the novices and therefore the mean times are not comparable.

Table 20

Defilade Position Selection on Missile, Duck Test

	Number of Soldiers		
Position	Novices (N = 31)	Experienced (N = 40)	Z
Correct	14 (45%)	26 (65%)	
Incorrect	17 (55%)	14 (35%)	1.671*

* $p < .10$

The subjective TC ratings of time related events were compared to actual times to see if a more objective evaluation of seemingly subjective criteria could be identified. Among experienced drivers, there was no significant difference in actual times between drivers in the fast enough and the too slow categories (Table 21). On the other hand, there was a significant difference in mean times between the novices with ratings of fast enough and too slow. The subjective evaluation was strongly associated with actual times for novices. The same pattern emerged from comparing actual time to TC subjective ratings of response (Table 22). There was no difference in actual times between experienced drivers with immediate and delayed responses, whereas th[illegible]e was a significant difference in actual time between the novices

with immediate and delayed ratings. It would appear that the TC evaluations are probably of little quantitative value, being highly dependent on the variability among people on estimating time and differing standards among people for placement into each subjective category.

Table 21

Time Statistics for Speed Ratings on Missile, Duck Test

		Time (Seconds)[1]			
Speed Rating		Novices	T	Experienced	T
Fast Enough		N = 17		N = 27	
	M	27.6		22.3	
	SD	14.3		8.9	
Too Slow		N = 10		N = 8	
	M	45.8	3.13*	22.5	.048
	SD	15.1		10.8	

* $p < .01$

1. The course was 200 meters longer for experienced drivers than for the novices and therefore the mean times are not comparable.

Table 22

Time Statistics for Response Ratings on Missile, Duck Test

		Time (Seconds)[1]			
Response Rating		Novices	T	Experienced	T
Immediate		N = 11		N = 25	
	M	26.1		22.4	
	SD	13.6		8.8	
Delayed		N = 16		N = 9	
	M	40.0	2.26*	23.0	.149
	SD	17.0		10.9	

* $p < .05$

A scorer was positioned at a distance of approximately 100 meters for novices and 50 meters for experienced drivers from the hide position. The scorer recorded two measures of exposure: a descriptive evaluation of

maintained concealment, intermittent exposure, or exposed throughout, and an mark on a drawing of the tank to indicate the portion exposed (see scoresheet in Appendix A).

On the first measure where the observer made a descriptive evaluation, some drivers were expected to pull into position initially, evaluate the position and then make position adjustments based on that evaluation. In fact, this action seldom occurred with novices or experienced drivers. Therefore, the scorers described the route just before the final position was taken. Except for Exposed Throughout, the actions described are neither right nor wrong. However, the measure is a fairly reliable description of what the driver did. It was found that more novices maintained concealment than experienced drivers (Table 23). There are two factors that could account for this finding. One is that there were many concealment opportunities enroute to the final position for the novices while the experienced drivers' route was almost totally clear before the hide position. The other factor is that the scorer for the novices was positioned at ground level while the experienced drivers' scorer was positioned on a rise in the ground where he was looking slightly down on the tank. While the bottom of the tank might be somewhat concealed, the scorer might not be able to determine this.

Table 23

Tank Exposure Pulling into Final Defilade Position on Missile, Duck Test

	Number of Soldiers	
Exposure	Novices (N = 24)	Experienced (N = 39)
Maintained Concealment	7 (29.2%)	0 (0%)
Intermittent Exposure	6 (25%)	18 (46.2%)
Exposed Throughout	11 (45.8%)	21 (53.8%)

Kolmogorov-Smirnov D = .292 $p > .10$

$\chi^2 = 15.420$, df = 2, $p < .001$

As a means of measuring exposure in the final position, scorers were provided a two view diagram of an M1 tank (see scoresheet, Appendix A) and told to mark with a line the portion of the tank they could see. Subsequently a grid was prepared (see Figure 1) which divided the tank into seven segments. This overlay was applied to each of the scorer's markings. If the scorer's marking included any part of a segment the entire segment was considered exposed. Table 24 shows the comparison of experienced drivers to novices on three categories of exposure: totally concealed (the correct position), hull concealed and turret exposed (partially correct position), and totally exposed (wrong position).

Table 24

Tank Exposure at Final Defilade Position on Missile, Duck Test

Exposure	Number of Soldiers: Novices (N = 16)	Experienced (N = 18)	Z^1
Tank Totally Concealed	1 (6.2%)	2 (11.1%)	
Hull Concealed/Turret Exposed	5 (31.2%)	12 (66.7%)	-2.330*
Tank Totally Exposed	10 (62.5%)	4 (22.2%)	

* $p < .05$

1. Based on Hull Concealed/Turret Exposed and Tank Totally Exposed categories only.

Neither group did well on the tank totally concealed category; however, experienced drivers tended to be partially concealed while novices tended to be fully exposed. A significant difference of proportions was based on two categories leaving tank totally concealed out since only one novice and two experienced drivers fell into this category. It should be pointed out that this test is highly terrain-dependent. During testing, the position for the defilade was just large enough to conceal the tank and allowed little tolerance in height or width for a slightly incorrect position. A larger terrain feature would not provide much discrimination.

One initial concern did not materialize. It was anticipated that later drivers could simply follow the tracks of previous drivers into the correct defilade position. Perhaps because drivers were so diverse in their reactions, this did not occur with the experienced drivers or novices.

React to TC Command - Hull Defilade. In almost all aspects of test administration and execution, this test is like the test of the Missile, Duck command. The prime difference is in the desired outcome. In Missile, Duck, the goal is to have the entire vehicle hidden, while in Hull Defilade, the turret must be exposed to allow engagement of targets. The TCs were instructed to rate whether there was mask clearance from the gun to the target (Table 25). Experienced drivers were not significantly better than novices in achieving a hull defilade position with mask clearance.

Time was recorded from issuance of the Hull Defilade command until the driver obtained his final position. The TCs also evaluated whether the speed was appropriate or too slow (Table 26). The proportion of experienced drivers who received speed ratings of appropriate was the same as novices. However, unlike the results obtained in a similar measure for Missile Duck, the novice results here did not correlate with actual time (Table 21), while the experienced drivers results did (Table 27). It should be noted that the mean time for experienced drivers is less than for novices, while the experienced drivers course was 50 meters longer than the novices.

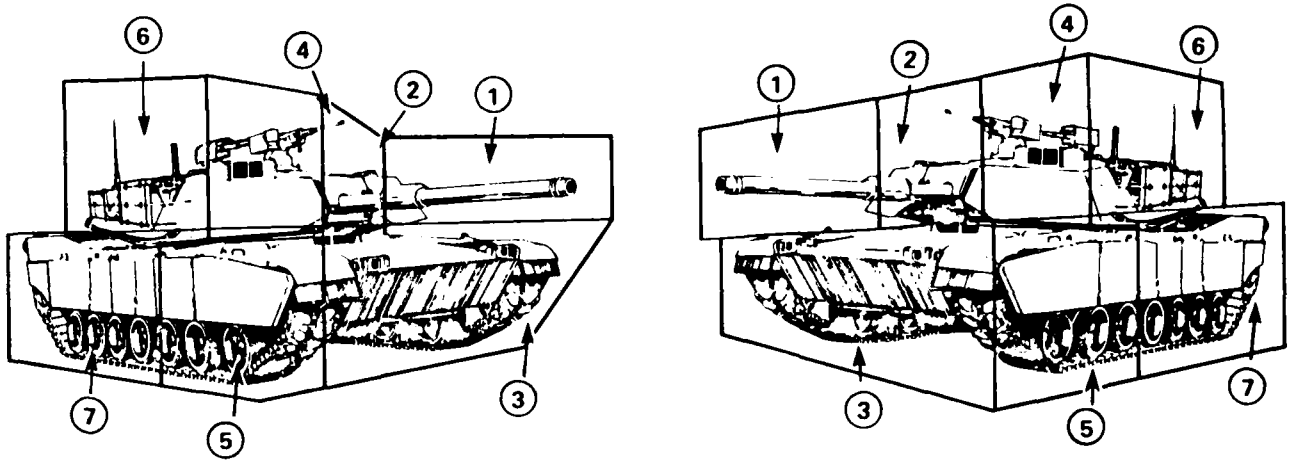


Figure 1 – **Tank Segments for Profile Scoring Method**

Table 25

Mask Clearance Obtained on Hull Defilade Test

	Number of Soldiers		
Mask Clearance	Novices (N = 22)	Experienced (N = 33)	Z
Obtained	13 (59.1%)	21 (63.6%)	-.340
Not Obtained	9 (40.9%)	12 (36.4%)	

Table 26

Speed Ratings on Hull Defilade Test

	Number of Soldiers		
Speed Rating	Novices (N = 26)	Experienced (N = 35)	Z
Appropriate	21 (80.8%)	29 (82.8%)	
Too Slow	5 (19.2%)	6 (17.2%)	.210

Table 27

Time Statistics for Speed Ratings on Hull Defilade Test

		Time (Seconds)[1]			
Speed Rating		Novices	T	Experienced	T
Appropriate		N = 21		N = 28	
	M	25.2		17.2	
	SD	11.7	.96	5.4	1.962+
Too Slow		N = 5		N = 6	
	M	31.4		35.5	
	SD	17.6		22.7	
Total[1]		N = 26		N = 34	
	M	26.6		20.4	
	SD	13.0		12.3	

* $p < .05$

1. The course was 50 meters longer for experienced drivers than for the novices and therefore the mean times are not comparable.

As with the Missile, Duck test, the ground observer measured tank exposure using the tank profile method. The method is described in the Missile, Duck test. This method is somewhat more complex in application and analysis for this test. For the Missile, Duck test total defilade was the goal, while Hull Defilade requirements for a "good" score demand that the hull be concealed while the turret is exposed to allow engagement. Because of similar terrain restrictions of the Missile, Duck test, the ground observer with the experienced drivers was stationed on a rise and looking slightly down on the tank and therefore able to see the hull more often than the novice scorer who was at eye level to the tank. Therefore, the results are somewhat predictable. The novices were significantly better than the experienced driver in positioning the tank with turret exposed and hull concealed (Table 28). It also should be noted that the defilade position for the experienced driver was a smaller area and therefore, led to a more difficult test. As with the Missile, Duck test, enough variation was observed in performance to conclude that tracking previous performers into the hull defilade position was not widespread.

Criterion Measures

The novice drivers took the M1 tank driver tests immediately following their daytime 30 minute driving instruction. The M1 test called for actions that had not previously been trained. Not surprisingly, the novice tank driver tests scores showed a great deal of variance for each of the obtained measures. The novice drivers' mean score for each measure was chosen as the minimal pass score for entry level soldiers who had completed the basic driving program. Obviously with increased and better training of the soldiers or if the test themselves are used in training, these scores should be surpassed.

Table 28

Tank Exposure at Final Defilade Position on Hull Defilade Test

	Number of Soldiers		
Exposure	Novices (N = 24)	Experienced (N = 31)	Z[1]
Turret and Hull Concealed	0	0	
Turret Exposed/Hull Concealed	16 (66.7%)	4 (12.9%)	4.114*
Turret/Hull Exposed	8 (33.3%)	27 (87.1%)	

* $p < .01$

1. Based on Turret Exposed/Hull Concealed and Turret/Hull Exposed categories only.

The experienced drivers had M60 and M1 tank driving experience. Driving experience on the M60 ranged from one month to 132 months and from one month to 26 months on the M1 tank. Most of the 2/6 Cav soldiers had unit driving experience at Fort Hood or overseas which included some unit tactical driver training. The 1st AIT/OSUT Bde holdover soldiers had been through the initial entry soldier driving program and then remained at Ft Knox. Their driving experience was mainly driving to and from ranges on black top and limited cross country driving. The soldiers had not driven in tactical scenarios. On most measures, the M1 tank driver test scores for these men were significantly less variable than for the novices. It was therefore, determined that the experienced drivers' mean score for each of the measures would represent an excellent score for entry level soldiers who had been through the driver training program.

It should be pointed out that the tactical tests were the ones in which there was no difference between novice and experienced drivers. This result was expected since experienced drivers in the sample had limited combat or tactical experience. Driving to and from ranges and driving in unit activities would help in the obstacle/judgment test such as right and left turns, and align tank for width but would not necessarily help in knowing a good hull defilade position. In essence, experienced in certain aspects of driving does not necessarily mean experienced in all aspects of driving.

The criterion scores for the measures obtained from the M1 Tank Driver Tests are shown in Table 29. No time measures were included because time is affected by many nonstandard variables such as terrain, weather, surface e conditions, vehicle conditions, and test distance differences between driving courses. It should be noted that the majority of measures other than time will likely remain fairly stable under variable testing conditions. However, users of these tests should consider speed as well as accuracy. Two experienced tank drivers could run through the course to establish a standard of excellence for that test administration. A passing time score for initial entry soldiers is harder to determine. The most reasonable approach is for one officer to subjectively evaluate each novice driver's speed through the tests. While it is not expected that each novice will drive as fast as the experienced drivers, it is expected that a reasonable speed be maintained dependent upon the terrain condition and amount of driver training previously obtained. A failure would consist of driving much to cautiously. For example, a driver might inch along to avoid hitting a stake or he might stop, move very slowly, and stop again while moving through a gate. In both cases, speed is being sacrificed for accuracy. For combat missions both speed and accuracy must be present. Therefore, while accuracy is important in these tests, speed also must be stressed.

DISCUSSION

Based on the initial results from novice drivers and test modifications used for the experienced drivers, there is evidence that these tests are potentially reliable quantitative instruments for measuring performance and producing criteria to use in yardstick comparisons with simulator-measured skills. The differences in performance between the novices and experienced drivers on the various parameters measured within the eight driving tests lead to the following conclusions. In the majority of the tests the

Table 29

Criterion Scores for M1 Tank Driver Tests

Test	Variable	Value
Follow Ground Guide Signals (40 meters)	Strikes	1 = passing 0 = excellent
	Time	Subjective evaluation = passing Experienced drivers' mean score = excellent
Right and Left Turns (40 meters)	Strikes	Right or Left 1 = passing 0 = excellent
	Radii	Right or Left 18 1/2 feet = passing 16 feet = excellent
	Time	Right or Left Subjective evaluation = passing Experienced drivers' mean score = excellent
Align Tank for Width (70 meters)	Strikes	Right or Left 1 = passing 0 = excellent
Width Judgement (60 meters)	Decisions	169 inch gate = passing 157 inch gate = passing 144 inch gate = excellent
	Strikes	169 inch gate = 0 passing 157 inch gate = 0 passing 144 inch gate = 1 passing 169 inch gate = 0 excellent 157 inch gate = 0 excellent 144 inch gate = 0 excellent
Control Tank During Main Gun Engagements (200 meters)	Time	Subjective evaluation = passing Experienced drivers' mean score = excellent
Acceleration and Stopping (60 meters)	Time	Subjective evaluation = passing Experienced drivers' mean score = excellent
	Feet	$\pm$ 12 feet = passing $\pm$ 9 feet = excellent
React to TC Command (Missile, Duck) (200 meters)	Time	Subjective evaluation = passing Experienced drivers' mean score = excellent
	Tank Concealed	partially = passing total = excellent
React to TC Command (Hull Defilade) (100 meters)	Mask Clearance	obtained = passing
	Time	Subjective evaluation = passing Experienced drivers' mean score = excellent
	Hull Concealed	partially = passing total = excellent

experienced drivers were significantly less variable in performance than the novices. Therefore, with experience in tank driving, performance becomes more consistent reflecting a fine tuning of the perceptual-motor skills involved. Also evident across the tests was the significant speed difference between experienced drivers and novices. Experienced drivers drive faster and with more confidence. In general, the experienced drivers also display high skill at the higher speeds. However, there were instances where errors resulted because the speed of the tank accentuated small variations in driving control. This was evident in the width judgment and align tank for width tests. Both tests require the tank to be driven through narrow spaces which leave little room for deviation from a straight line approach. Driving fast over rough terrain caused the tank to bounce just enough to at times hit a stake or engineering tape. While these hits were counted as errors, one must keep in mind that under combat situations fast driving with minor deviations in path might well be more advantageous than very slow driving with no deviation in path. Each test will be discussed and changes in test design identified when indicated by the data.

It was determined that on the Follow Ground Guide Signals test that only one turn, right or left, need be tested. While the left turn is more difficult than the right, this difference disappeared with experience. Experienced drivers displayed more confidence in their skill in driving in reverse as evidenced by their consistent speed and smooth maneuvering. On the other hand, novices tended to become confused on which way to steer to maneuver the tank in reverse. Since the tank steers opposite a car when moving in reverse, novices with little practice must cognitively determine which way to turn the steering mechanism. However, experienced drivers have established a habit pattern and steer with no conscious effort.

An analysis of Right and Left Turn tests determined the right turn to be more difficult for both groups than the left as displayed by number of strikes. The probable explanation is that the driver's hatch is on the right side and when open partially obscures the driver's vision. The experienced drivers had fewer strikes on both turns than the novices and were less variable in their radius scores. The importance of this test can be readily identified when looking at the tight radius turns necessitated by narrow streets in Europe. The biggest problem in making these turns is turning to wide causing the right rear of the tank to swing out and hit corners of buildings. This problem was also experienced during the Align Tank for Width test.

For the Align Tank for Width test, drivers had to turn into a narrowing wedge shaped path and turn out of the path at its narrowest section. Many of the novice errors occurred at the exit when the right rear of the tank hit the right barrier while turning left. The experienced drivers did not manifest this problem. Experienced drivers exited the course turned right and did not hit the left barrier. As in the right and left turns tests, the experienced drivers were observed to maintain a smaller radius than the novices when exiting the Align Tank for Width Test. When strikes on both sides were counted, novices had significantly more strikes than the experienced drivers. In future testing, a separate tally should be kept of strikes occurring at the exit turn since this maneuver is different from keeping the tank aligned within the narrowing wedge.

The Width Judgment test was comprised of two tasks. One task involved making the decision to go through or bypass a set of gates. The second task was to maneuver the tank through or bypass the gates once the decision had been made. The width of the M1 tank with skirts is 143.75 $\pm$ .54 inches. One set of gates was placed at 144 inches, impossible to maneuver through. Experienced drivers had no problem making the correct decision to pass through the widest 169 inch gate while the novices did have trouble making the correct decision. On the narrowest 144 inch gate, and on the 157 inch gate experienced drivers had as many problems making the correct decisions as did the novices. It appears that with experience, perceptual judgments such as what width the tank can pass through do become better. However, when that width is within 13 inches of being too narrow, experience helps but not enough to make a significant difference between experienced drivers and novices. Experienced drivers and novices were as likely to strike a passable gate. Test scores offered a possible explanation for the similar error results between experienced drivers and novices. They felt that the novices hit the barriers even though they drive slowly, because they were not skilled at precision driving, while experienced drivers drove more quickly, sacrificing precision for speed. Performance on this test may also have been effected by drivers' confidence. Perhaps experienced drivers realized that the 144 inch gate was probably too small, but they wanted to try it anyway to "show off" their skills.

In the Control Tank for Main Gun Engagement test, the measure of maintain steady platform was obtained by counting the number of transmission shifts that occurred during the engagement. Scorer reliability during this test fluctuated on this measure and therefore it will be dropped from the overall test. The experienced drivers drove a shorter course and took a longer time than the novices. One possible explanation for these results is that the experienced drivers had a rougher course than the novice course and the experienced drivers had to orient the tank to the target whereas the novice target was straight ahead. More data with novices and experienced drivers on the same course needs to be collected on this test before any definite conclusions can be drawn. One would expect, however, based on the other tests that experienced drivers would drive faster and be less variable than the novices when conditions are similar.

Acceleration and Stopping test measures the skills of judging tank stopping distance and ability to control the tank in rapid acceleration/deceleration conditions. Those skills are inherent in the pop-up firing techniques. The experienced drivers had a longer course but demonstrated shorter time than the novices. There was no difference in absolute distance from the stopline between experienced drivers and novices. However, the experienced drivers had more variability in their stop distance scores than the novices. One possible explanation is that the experienced drivers while driving a longer distance drove much faster than the novices, and therefore, took longer to stop. This conclusion is supported by the fact that twelve experienced drivers went beyond the stop-line while no novices did. The goal of this test was to both cover the ground quickly and stop smoothly at the stopline. The subjective evaluation of the stopping quality was noted as smooth, jerky, or abrupt. Drivers should not alter gunners sight pictures by a jerky or abrupt stop. Both experienced drivers and novices were divided equally between smooth and jerky stops with considerably fewer drivers scoring in the abrupt category. Both groups scored about 60% in the non-smooth response

categories. One problem with the M1 tank is that the brakes are very sensitive and the tank stops quickly. It is not clear why experienced drivers, who should be accustomed to braking the tank, still were no better than the novices. It was expected that the novices would have problems with stopping smoothly since they were not accustomed to sensitive brakes and tremendous stopping power of the M1.

In the react to TC Command - Missile, Duck test the objective is to respond and move as rapidly as possible, after the command is given, to a complete turret defilade position. A TC subjective rating was given to speed response categories. The data indicated that these ratings did not correlate with actual times for experienced drivers. It would appear that the TC evaluations are of little quantitative value, being highly dependent on the variability among people in estimating time, and differing standards among people for placement into each subjective category. Even though the subjective ratings did correlate to the actual driving times of novices, it was determined that the variability in novices driving speed made it easier to group them into categories than the relatively consistent driving times of experienced drivers. Therefore, the subjective evaluations were deemed not useful in the total analysis and will not be included in the test package.

Scorer ratings on measures of exposure were also complicated by the actions taken by the drivers and the instructions to the scorers. The rating was supposed to measure the actions taken by the driver after he pulled into position and then repositioned the tank to the final position. The drivers seldom adjusted their position and ratings were based on the final portion of the route before the drivers stopped. This was not the intent of the measure and furthermore the final routes for the two groups were sufficiently different so that the ratings were not of much use for comparison purposes. The final section of the route for the novices had several concealment opportunities while the route for experienced drivers was virtually clear immediately prior to the hide position. This measure does have potential because it is an accurate description of driver actions. A problem in accurately scoring the measure arose when it became apparent the scorer could not determine whether the lower portion of the hull was concealed. The scorer was standing on a rise looking down on the tank. Scorers must be at groundlevel to accurately score.

The primary objective of the missile duck test was to position the tank into a turret defilade position. Both groups had problems accomplishing the goal. One reason this test proved difficult is that it is highly terrain-dependent. During the testing the defilade position was large enough to conceal the tank and allowed little tolerance in height or width for a slightly incorrect position. However, a larger terrain feature would not provide much discrimination in the ability to hide the tank. One must conclude from the results of this test, that driving the tank to a turret defilade position is a skill that needs more training, practice, and sustainment training in the Army.

React to TC Command - Hull Defilade was similar in test administration and execution to the missile duck test except that the goal is to expose the turret (mask clearance) for target engagement. TC's rated the drivers on whether mask clearance was attained. Again, neither group was very good at attaining mask clearance. Unlike the Missile Duck test, the TC's ratings on

INSTRUCTIONS TO THE DRIVER: During this test you must judge whether you can pass through three openings. If you think you can pass, drive the tank between the pylons (or stakes) without hitting them. If you think it is too narrow, you must drive around to the (right or left). I cannot help you in making the decision or driving between the markers. You will drive open hatch. Do you have any questions?

TEST ADMINISTRATION (TC):

1. Position the tank at the start point.

2. Read the instructions to the driver.

3. When the driver is ready, command DRIVER, MOVE OUT and signal the scorer.

4. Do not assist the driver in deciding whether to pass through the gates or during the passage. No TC scoring is required.

5. If the driver pulls up to a gate and then decides he wants to bypass, you may assist him in backing up.

TEST ADMINISTRATION AND SCORING (GROUND OBSERVER):

1. Mark the width of each of the gates on the scoresheet.

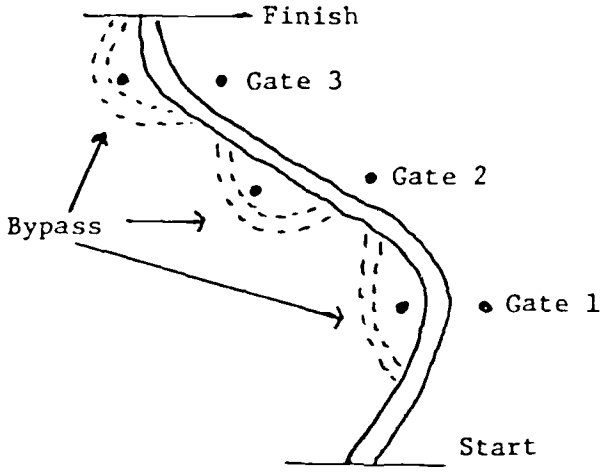
2. Position yourself where you can observe all three gates and the finish point.

3. Record for each gate whether the driver passed through or bypassed. Circle for each gate whether the tank cleared the gate. If any part of the tank touches the stake or pylons, circle NO.

4. Adjust the width of at least two of the gates after each run. One of the two must be the narrowest gate (144"). The width of the gates must be exact for each run. Use an assistant to help adjust the switch.

WIDTH JUDGMENT

TEST CONDITIONS: Test is conducted in open terrain with three sets of pylons or portable stakes set up at approximately 50' intervals and offset. There must be sufficient room to bypass each set of width markers. Markers must be movable so that adjustments can be made between tests. Markers will be set up at widths of 157", 169", and 144".



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
20' engineer tape
4 - 2' stakes
6 - 5' stakes or pylons
50' measuring tape

Personnel:

1 TC
1 Scorer

TEST PREPARATION:

1. Set up the three sets of gates at widths of 157", 169" and 144". Set up the gates so that all three are not in a straight line.

2. Mark a start and finish point with the short stakes.

3. Drive each bypass area at least once to mark it.

4. Vary the width of each gate after each run using the same three widths but moving the location, i.e., if Gate 1 was 144" for the first run it should be adjusted to 169" for the second examinee and so on.

SCORESHEET

FOLLOW GROUND GUIDE SIGNALS

Examinee Name:_____ Date & Time:_____

Trial Number:_____ TC:_____

Turn: Right_____ Left_____ Scorer:_____

MEASURES:

1. Strike: Yes_____ No_____

2. Time:_____

COMMENTS: _____

_____

_____

_____

INSTRUCTIONS TO DRIVER: During this test you will drive the tank following a ground guide. You will be required to back the tank as the ground guide directs. Leave your hatch open. Are there any questions?

TEST ADMINISTRATION (GROUND GUIDES):

1. One ground guide is positioned in the rear of the tank; the other provides the signals to the driver.

2. The first signal given will be to start the tank.

3. Give ground guide signals as necessary to get the tank through the course keeping the tank as close as possible (within two inches except at the turn) without striking the tape.

4. If you give an incorrect signal causing the tank to touch any of the barriers, notify the scorer.

TEST ADMINISTRATION AND SCORING (GROUND OBSERVER):

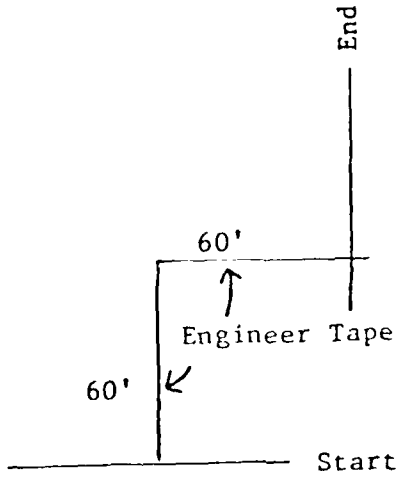
1. Start timing when the ground guide gives the first signal. Stop timing when the front of the tank clears the end point.

2. Record if the tank touches the engineer tape, stakes, or pylons.

3. If there was a barrier strike caused by an incorrect ground guide signal do not count this as a barrier strike.

FOLLOW GROUND GUIDE SIGNALS

TEST CONDITIONS: Conducted on hard surface with one side marked with engineer tape. (NOTE: The same site that is used for Right and Left Turns may be used.) Pylons or stakes should be set up a distance of 18' out from the turn and the entrance and exit width set at 13'.



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
130' engineer tape
6 - 5' stakes or pylons
4 - 2' stakes
1 - stopwatch
50' measuring tape

Personnel:

1 TC
1 Scorer
2 Ground Guides

TEST PREPARATION:

1. Erect the engineer tape along the inside (right hand) of the lane.

2. Place pylons or stakes at a distance of 13' at the entrance and exit points and 18' out from the 90° turn.

TEST ADMINISTRATION (TC):

1. Back the tank up to the starting point and positioned within one foot of the engineer tape.

2. Read the instructions to the driver.

3. Do not give any assistance or guidance to the driver during the test. No scoring is required from the TC.

SCORESHEET

RIGHT AND LEFT TURNS

Examinee Name:_____ Date & Time:_____

Trial Number:_____ TC:_____

Scorer(s):_____

MEASURES:

RIGHT TURN: 1st_____ 2d_____

Radius of right turn:_____

Strikes: Before Turn: 1___ 2+___ During Turn: 1___ 2+___

After Turn: 1___ 2+___

Time: _____

LEFT TURN: 1st_____ 2d_____

Radius of left turn:_____

Strikes: Before Turn: 1___ 2+___ During Turn: 1___ 2+___

After Turn: 1___ 2+___

Time: _____

COMMENTS: _____

_____

_____

_____

INSTRUCTIONS TO THE DRIVER: During this test you must drive this lane staying as close as possible to the engineer tape without hitting the tape. After you complete the first run we will turn the tank around and you must complete the course again from the opposite direction. I will not be able to assist you during the course. You will drive with your hatch open. Do you have any questions?

4. If necessary, assist or direct the driver in turning around after he has passed the end point.

5. Direct the driver to stop at the "end" point after the turn around.

6. Command DRIVER, MOVE OUT and signal the scorer.

7. If the driver asks if he should pivot turn tell him he may.

8. Do not assist the driver in making the turn. No scoring is required from the TC.

TEST ADMINISTRATION AND SCORING (GROUND OBSERVERS):

1. Position one scorer on the inside (engineer tape side) of the lane and the other on the outside.

2. One scorer must keep track of time. Start the time when the TC signals and stop the time when the rear of the tank clears the end point.

3. The inside scorer will observe and record if the tank touches the engineer tape or stakes.

4. The outside scorer will mark the widest point reached by the rear of the track on the turn.

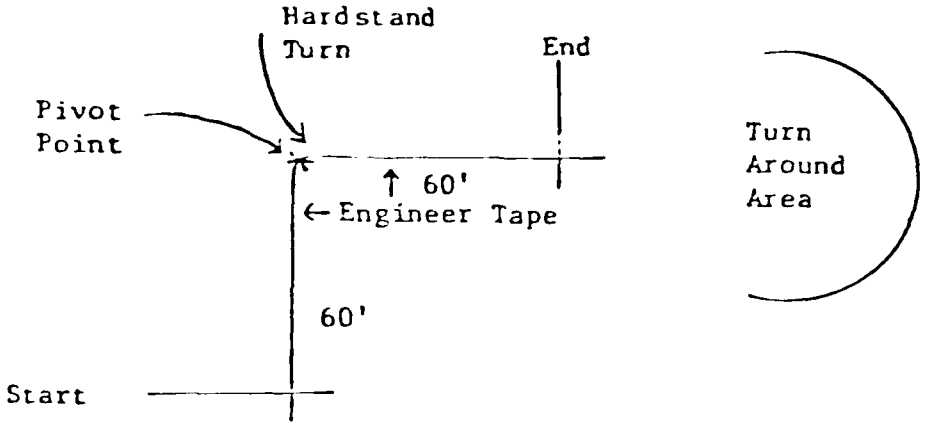
5. Measure the distance from the pivot point to the widest point reached on the turn.

6. Sweep dirt over the turn to assist in scoring the left turn.

7. Repeat the scoring process for the left turn.

RIGHT AND LEFT TURNS

TEST CONDITIONS: A hardstand allowing a right/left angle is required. An approach and exit "lane" each approximately 20 meters long is required and a turnaround area after the end point is required, i.e., (Note: The same site that is used for Follow Ground Guide Signals can be used.)



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
130' engineer tape
6 - 5' stakes or pylons
4 - 2' stakes
50' measuring tape
1 - stopwatch
1 - broom

Personnel:

1 TC
2 Scorers

TEST PREPARATION:

1. Erect the engineer tape on stakes or pylons on the inside of the turn at or slightly below fender height. The tape must make a 90° angle at the pivot point.

2. Mark the start and end points with stakes and engineer tape.

3. Spread a light covering of dirt over the hardstand at the turn to assist in scoring the radius of the turn.

TEST ADMINISTRATION (TC):

1. Position the tank at the start point.

2. Read the instructions to the driver.

3. When the driver is ready command DRIVER, MOVE OUT and signal the scorer.

APPENDIX A
TANK DRIVER PERFORMANCE TESTS

REFERENCES

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Staff. (1982, July). M113 and M60 accidents indicate operational weaknesses. Countermeasure, p. 1.

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speed did not correlate with actual times of the novices, but did correlate to experienced drivers actual time. The variability in the time scores was similar between both groups. As with the Missile Duck test, the subjective rating will not be used in future tests. Scorer positioning again affected results, because the scorer for experienced drivers was on a rise, he could not always tell if the hull was concealed or not. Another problem was that the defilade position for experienced drivers was a smaller area than for novices and therefore was a more difficult task. Because of these problems, it is not surprising that the novices were better at attaining a hull defilade position.

It is clear that there are hazards and pitfalls in using these types of tests for comparative purposes if the tests are administered at different times or on slightly different terrain. Many of the tests are highly terrain/environment dependent and slight variations in ground surface, distance, or weather can affect them. This does not invalidate what was done or the resulting group differences. However, it does give more alternatives as to why particular results might have been obtained. More importantly, if the tests are used in the future with the criterion scores as outlined here, those criterion scores might not be met because of terrain/environment differences.

SCORESHEET

WIDTH JUDGMENT

Examinee Name:_____ Date & Time:_____

Trial Number:_____ TC:_____

Scorer(s):_____

MEASURES:

GATE 1 Width:_____

1. Passed through _____ Bypassed _____

2. Strike: YES _____ NO _____

GATE 2 Width:_____

1. Passed through _____ Bypassed _____

2. Strike: YES _____ NO _____

GATE 3 Width:_____

1. Passed through _____ Bypassed _____

2. Strike: YES _____ NO _____

COMMENTS: _____

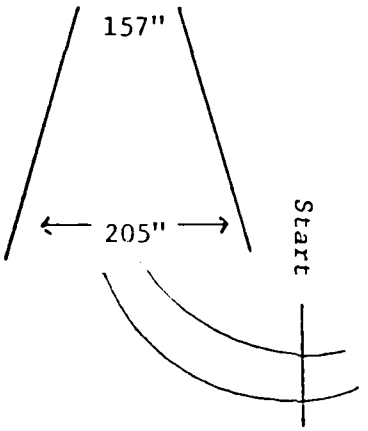
_____

_____

_____

ALIGN TANK FOR WIDTH

TEST CONDITIONS: A hardstand area approximately 20 meters long is required marked on both sides with pylons/engineer tape. The lane starts at 205" and narrows to 157" at the exit end. A start area not aligned with the lane is required.



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
130' engineer tape
6-9 - 5' stakes or pylons
2 - 2' stakes
Felt marker
50' measuring tape

Personnel:

1 TC
2 Scorers

TEST PREPARATION:

1. Erect the engineer tape on both sides of the lane so that it measures 205" wide at the wide end and narrows to 157" wide at the exit end. Tape must be at or slightly below fender level.

2. Select a start point that is not aligned with the entrance to the course and mark with the short stakes and engineer tape.

TEST ADMINISTRATION (TC):

1. Position the tank at the start point.

2. Read the instructions to the driver.

3. When the driver is ready, command DRIVER, MOVE OUT and signal the scorer.

4. Do not assist the driver in maneuver during the course except if he has to back up to correct his alignment. You may then assist him by directing him to stop before he backs into the engineer tape barrier. Inform the scorer after the run that you assisted in backing.

5. No scoring is required by the TC.

TEST ADMINISTRATION AND SCORING (GROUND OBSERVER):

1. Position one scorer on each side of the lane.

2. Record if the tank strikes the engineer tape or stakes.

INSTRUCTIONS TO THE DRIVER: During this test you must navigate the passage without striking the stakes or engineer tape. I will not assist you in lining up the tank. You will drive with the hatch open. Do you have any questions?

SCORESHEET

ALIGN TANK FOR WIDTH

Examinee Name:_____ Date & Time:_____

Trial Number:_____ TC:_____

Scorer:_____

MEASURES:

RIGHT SIDE

Strike: Yes_____ No_____

COMMENTS: _____

_____

_____

_____

SCORESHEET

ALIGN TANK FOR WIDTH

Examinee Name:_____ Date & Time:_____

Trial Number:_____ TC:_____

Scorer:_____

MEASURES:

LEFT SIDE

Strike: Yes_____ No_____

COMMENTS: _____

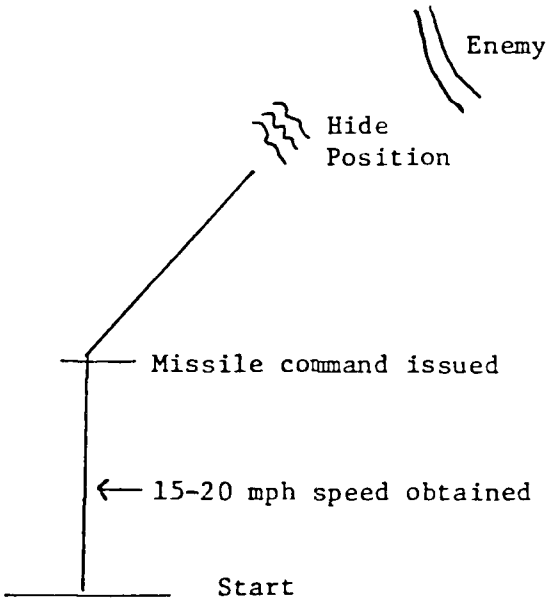
_____

_____

_____

REACT TO TC COMMAND - MISSILE, DUCK

TEST CONDITIONS: Terrain allowing tank speed of 15-20 mph and an area approximately 200 meters long and 50 meters wide is required. At least one adequate hide position is required which must be visible during the approach portion of the driving.



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
1 - binoculars
4 - 2' stakes
1 - stopwatch
20' engineer tape

Personnel:

1 TC
1 Scorer

TEST PREPARATION:

1. Select an enemy location that is visible from the start point and from the hide position. The enemy location should be a minimum of 500 meters from the hide position.

2. Mark the start point with a stakes and engineer tape.

3. Identify a location for issuing the command. This location should be far enough from the start point to allow the driver to reach 15-20 mph and about 10-12 seconds from the nearest acceptable position, and visible from the enemy location. If the location is not marked naturally (such as by a tree), mark the location with stakes and engineer tape.

TEST ADMINISTRATION AND SCORING (TC):

1. Position the tank at the start point.

2. Read the instructions to the driver.

3. Insure the driver has the hatch closed before starting the test.

4. When the driver reaches the location for issuing the command, announce MISSILE, DUCK. Begin timing.

5. If the driver does not reach an estimated 15 mph before the location for the announcement, tell him to speed up.

6. When the driver reaches his final position, stop timing and signal the observer.

7. Do not assist the driver in moving to or into the hide position.

TEST ADMINISTRATION AND SCORING (OBSERVER):

1. Select and mark a position at the enemy location. Use this position each time the test is run. If at 500 meters or less, always observe in the same body position, i.e., standing, kneeling or sitting.

2. Rate the amount of exposure after the initial stop.

3. Observe the tank through the binoculars. When the TC signals that the driver is in the final position, outline the portion of the tank that is visible using the tank pictures on the scoresheet.

SCORESHEET

REACT TO TC COMMAND - MISSILE, DUCK

TC EVALUATION

Examinee Name: _____ Date & Time: _____

Trial Number: _____ TC: _____

Scorer: _____

INSTRUCTIONS TO DRIVER: During this test you must react to a command given by the TC. The _____ (indicate location) is a suspected enemy location. You must operate with your hatch closed and at an initial speed of 15-20 mph. Once I issue you the command I will not assist you in following the command. Do you have any questions?

MEASURES:

1. Which describes the acceleration after the command? (Circle one)

   Speed: Fast Enough Too Slow

   Timing: Immediate Delayed

2. Time from command to final position: _____

COMMENTS: _____

_____

_____

_____

SCORESHEET

REACT TO TC COMMAND - MISSILE, DUCK

OBSERVER EVALUATION

Examinee Name:_____ Date & Time:_____

Trial Number:_____ TC:_____

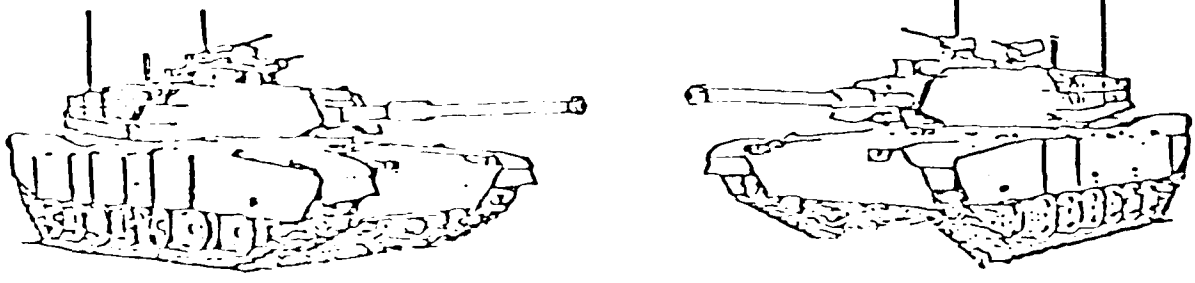
Scorer:_____

MEASURES:

1. Which describes tank after initial stop? (Circle one)

   Maintained concealment Intermittent Exposure Exposed Throughout

2. Outline portion of tank exposed after final stop:



COMMENTS: _____

_____

_____

_____

4. Command DRIVER, MOVE OUT and start the time.

5. Stop the time when the tank comes to a halt.

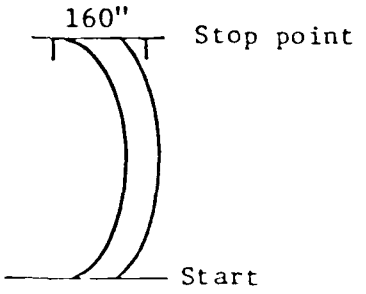
6. Do not allow the driver to adjust the position of the tank once he stops.

TEST ADMINISTRATION AND SCORING (GROUND OBSERVER):

Measure the distance forward or back to the stop line from the edge of the front slope.

ACCELERATION AND STOPPING

TEST CONDITIONS: Test conducted in terrain allowing a hull defilade position. Terrain should be uneven and uphill or inclined if possible. Concealment should be present and terrain may be wooded. A track, approximately 90 meters long, is identified on the ground. This should not be a straight line. A stop point must be identifiable on the ground by the driver. Right and left limits should also be defined at the stop point approximately 160" wide, i.e.,



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
30' engineer tape
8 - 2' stakes
1 - stopwatch
Measuring tape

Personnel:

1 TC
1 Scorer

TEST PREPARATION:

1. Mark the stop point on the ground with engineer tape marking the forward point and right and left limits 160" wide. Secure the engineer tape for the right and lift limits flush to the ground.

2. Mark the start point on the ground.

TEST ADMINISTRATION AND SCORING (TC):

1. Position the tank at the start point with the gun tube centered over the front slope.

2. Read the instructions to the driver. If the stop point cannot be seen from the start point, walk the driver to a point where he can observe it.

3. Insure the driver has his hatch locked, transmission in park and engine at tactical idle before issuing the command.

SCORESHEET

ACCELERATION AND STOPPING

TC EVALUATION

Examinee Name:_____ Date & Time:_____

Trial Number:_____ TC:_____

Scorer:_____

INSTRUCTIONS TO DRIVER: During this test you must move from your present location to a firing position marked by the _____. You must move as rapidly as possible but you will also be scored on the smoothness of your move. In other words, you must not cause the gunner to lose or delay his sight picture. You must stop as close as possible to the _____. Once the tank stops you will not be allowed to adjust the position. Close the hatch and place the tactical idle switch on. Leave the transmission in P and the parking brake on until I tell you to move. Move out when I give you a command to stop; you must stop on your own. Any questions?

MEASURES:

1. Stop (Circle one):

   Smooth Jerky Abrupt .

2. Time from command move out to stopping: _____

COMMENTS: _____

_____

_____

_____

SCORESHEET

ACCELERATION AND STOPPING

GROUND OBSERVER EVALUATION

Examinee Name:_____ Date & Time:_____

Trial Number:_____ Scorer:_____

MEASURES:

1. Distance from Stop line:

Over _____

Short _____

COMMENTS: _____

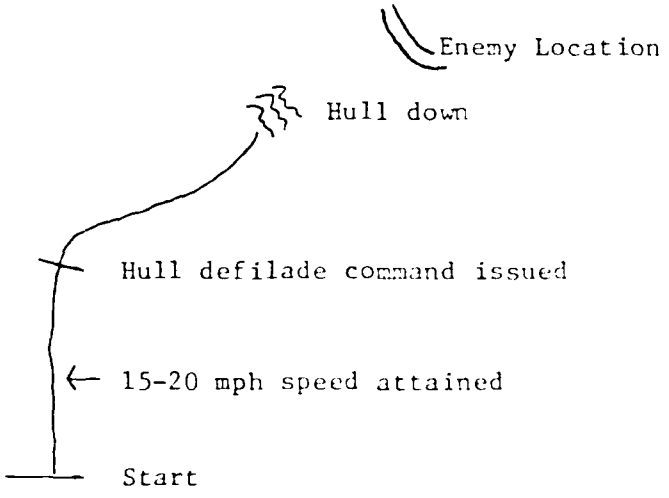
_____

_____

_____

REACT TO TC COMMAND - HULL DEFILADE

TEST CONDITIONS: Terrain allowing tank speed of 15-20 mph and an area approximately 200 meters long and 50 meters wide is required. At least one adequate hull defilade position must be visible during the approach portion of the driving.



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
1 - binoculars
2 - 2' stakes
20' engineer tape
1 - stopwatch
1 - target

Personnel:

1 TC
1 Scorer

TEST PREPARATION:

1. Select an enemy location that is visible from the start point and from the hull defilade position. The enemy location should be a minimum of 500 meters from the defilade position.

2. Mark the start point with the stakes and engineer tape.

3. Identify a location for issuing the command. This location should be far enough from the start point to allow the driver to reach 15-20 mph and about 10-12 seconds from the nearest acceptable hull defilade position, and vixible from the enemy location. If the location is not marked naturally (such as by a tree), mark the location with stakes and engineer tape.

TEST ADMINISTRATION AND SCORING (TC):

1. Position the tank at the start point.

2. Read the instructions to the driver.

3. Insure the driver has the hatch closed before starting the test.

4. When the driver reaches the location for issuing the command, announce DRIVER, HULL DEFILADE. Begin timing.

5. If the driver does not reach an estimated 15 mph before the location for the announcement, tell him to speed up.

6. The driver may adjust his position once he arrives at the hull defilade location. Keep track of the number and type of adjustments.

7. When the driver reaches his final position, stop timing and signal the observer.

8. After the driver reaches his final position, look through the GPS extension and adjust the gun if necessary. If you can see the enemy location score Measure 1 YES.

9. Do not assist the driver in moving to or into the defilade position.

TEST ADMINISTRATION AND SCORING (OBSERVER):

1. Select and mark a position at the enemy location. Use this position each time the test is run. If at 500 meters or less, always observe in the same body position, i.e., standing, kneeling or sitting.

2. Observe the tank through the binoculars. When the TC signals that the driver is in the final position, outline the portion of the tank that is visible using the tank pictures on the scoresheet.

SCORESHEET

REACT TO TC COMMAND - HULL DEFILADE

TC EVALUATION

Examinee Name:_____ Date & Time:_____

Trial Number:_____ TC:_____

Scorer:_____

INSTRUCTIONS TO DRIVER: During this test you must react to a command given by the TC. The _____ (indicate location) is a suspected enemy location. You must operate with the hatch closed and at an initial speed of 15-20 mph. Once I issue you the command I will not assist you in following the command. Do you have any questions?

MEASURES:

1. Was mask clearance obtained? YES ____ NO ____

2. Speed entering position (Circle one):

   Appropriate Too Slow

3. Time from command to final position: _____

COMMENTS: _____

_____

_____

_____

SCORESHEET

REACT TO TC COMMAND - HULL DEFILADE

ENEMY OBSERVER EVALUATION

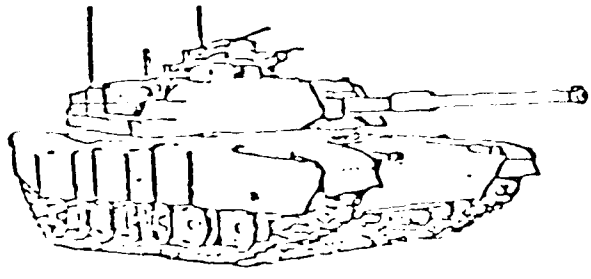
Examinee Name:_____ Date & Time:_____

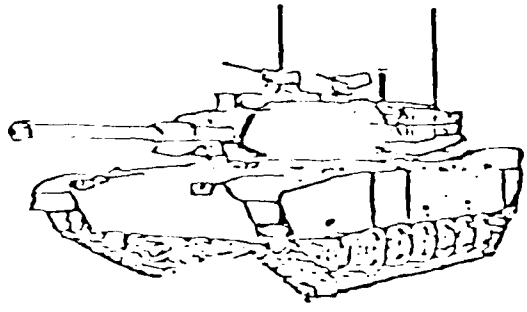
Trial:_____ TC:_____

Scorer(s):_____

MEASURES:

Outline postion of tank exposed; use both pictures if necessary for both sides.





COMMENTS: _____

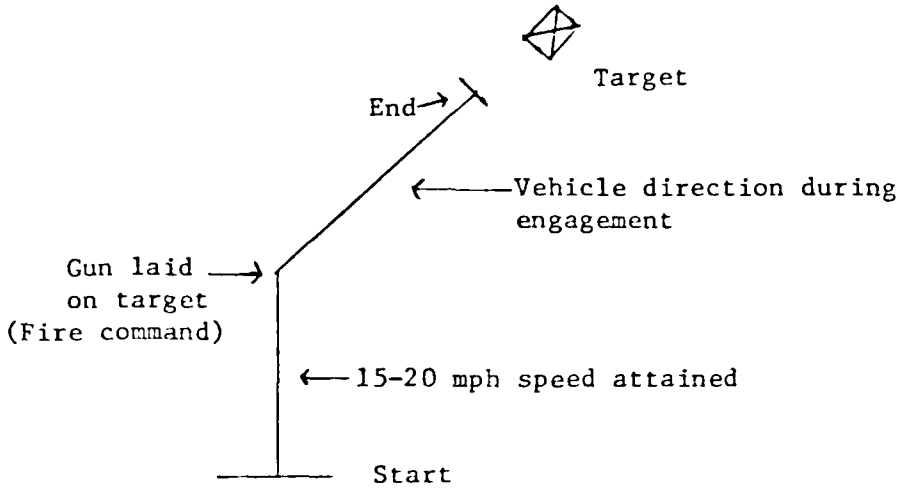
_____

_____

_____

CONTROL TANK DURING MAIN GUN ENGAGEMENT

TEST CONDITIONS: Terrain allowing tank speed of 15-20 mph and an area at least 250 meters long is required for the test. At least part of the terrain (during the engagement portion) must be off road. A target should be placed to facilitate laying the gun and evaluating the driving. The target should be located approximately 30° off the initial direction of travel, approximately 500 meters from the vehicle path in a location that can be viewed continuously from the gunner's position.



EQUIPMENT/PERSONNEL REQUIRED:

Equipment:

1 - M1 tank
Target, 24" x 24"
1 - stopwatch
6 - 2' stakes
20' engineer tape
2 - 2" x 2" x 8' stakes

Personnel:

1 TC
1 Gunner

TEST PREPARATION:

1. Set up the 24" x 24" panel at a distance of approximately 500 meters. Insure that the panel can be observed from the fire command issue point on.

2. Mark the start point, the end point and the point where the fire command will be issued.

TEST ADMINISTRATION AND SCORING (TC):

1. Position the tank at the start point. Center the gun tube over the front slope.

2. Read the instructions to the driver.

3. Insure the driver has his hatch locked before starting the test.

4. When the driver reaches the point for issuing the command, issue a fire command. Start timing on the alert element GUNNER.

5. When the driver reaches the stop point announce CEASE FIRE and stop timing.

6. If the driver does not reach an estimated 15 mph before the location for issuing the fire command, tell him to speed up.

7. Count the number of times that the transmission shifted up or down between the alert element of the fire command and CEASE FIRE and enter it on the scoresheet. Do this without consulting with the gunner.

TEST ADMINISTRATION AND SCORING (GUNNER):

1. Announce IDENTIFIED as soon as the TC lays you on the target.

2. Attempt to maintain the cross hairs on the 24" x 24" panel from IDENTIFIED until CEASE FIRE. Estimate the percent of time you were able to keep the crosshairs on the target and mark it on the scoresheet.

3. Count the number of times that the transmission shifted up or down between the alert element of the fire command and CEASE FIRE and enter it on the scoresheet. Do this without consulting with the TC.

SCORESHEET

CONTROL TANK DURING MAIN GUN ENGAGEMENT

TC EVALUATION

Examinee Name:_____ Date & Time:_____

Trial Number:_____ TC:_____

Scorer:_____

INSTRUCTIONS TO DRIVER: During this test you will drive the vehicle during a moving main gun engagement. You must have your hatch closed. You must keep the front of the tank oriented on the enemy location. The required speed is 15-20 mph. Do you have any questions?

MEASURES:

1. Oriented the front of the tank towards the enemy. YES____ NO____
2. Number of times that transmission shifted after fire command: _____
3. Time from alert element to CEASE FIRE: _____

COMMENTS: _____

_____

_____

_____

SCORESHEET

CONTROL TANK DURING MAIN GUN ENGAGEMENT

GUNNER EVALUATION

Examinee Name: _____ Date & Time: _____

Trial Number: _____ Gunner: _____

Scorer: _____

MEASURES:

1. Percent of time after fire command that reticle was on target:

100 75 50 25 0

|_____|_____|_____|_____|

2. Number of times that transmission shifted after fire command: _____

COMMENTS: _____

_____

_____

_____